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by

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"PERTH'S WATER SUPPLY"

PERTH'S WATER SUPPLY

Gentlemen—

Introduction

Four years ago in 1967, Mr. Gillies in his Chairman's address, discussed some of the difficulties of providing the community with electricity. Tonight I propose to discuss the provision of water to Perth and some problems in connection with this provision. The problems of the State Electricity Commission and those of the Metropolitan Water Board in providing these services, have much in common, but they also have substantial differences. For example, both are concerned with base loads and with peak loads. With the S.E.C. the peak load problem is paramount but in the case of the Water Board it is subordinate in importance. This evening, while touching briefly on the manner of these peaks, I propose to deal mainly with the growing annual demands and the problems of meeting them.

I shall first of all explain the existing water supply system.

Catchments:

The great bulk of Perth's water is gathered from the Board's catchments in the Darling Range. These extend from Bickley in the north, through Canning, Churchmans, Wungong and Serpentine to the North and South Dandalup catchments in the south. The Board has five dams, Victoria which now mainly serves Kalamunda, Canning, Churchman and two on the Serpentine. It also has three pipeheads which direct river flow into the system, but do not provide storage. These are on Kangaroo Gully, the Wungong and on the North Dandalup Rivers.

To the north of the Board's most northerly catchment is that of Mundaring on the Helena, which serves the Goldfields and parts of the wheatbelt. Further north again are some useful tributaries of the Swan which will probably also be used for country areas. South of the South Dandalup is the Murray catchment. This catchment is of interest and importance to the Board and I shall discuss it further later. Further again to the south are a number of good rivers. The best of these are already in use for irrigation and the water supply of rural communities and the remainder are allocated for similar purposes.

The Hills system not only provides over 90% of our water, but it provides our best and cheapest water. Unfortunately, the cheapest hills resources have already been exploited. Even more unfortunately as we shall see, the supplies of really good water in the Hills are not sufficient by themselves to keep our expanding city going for many years.

Underground Water:

(i) **Artesian**

Fifteen artesian bores supply almost all of the remainder of our water. The extent of the artesian supplies are difficult to determine but we do know much about the quality of the water on the various aquifers. In a very general way we can say for example that water from the deepest bores is too hot and too saline to be palatable and that water from the shallower bores

usually requires treatment for iron before it can be used. At present, with minor exceptions, no artesian water is supplied directly to consumers except as a mixture with Hills water or following treatment.

(ii) **Unconfined**

The third source of water is unconfined ground water. Since late last year when a new water treatment plant was commissioned at Mirrabooka, a small quantity of this water has been supplied to the system. The commissioning of this plant was an important milestone in the development of the metropolitan supply.

Unconfined underground water is of course already used by the community in private wells and bores and for parks, playing fields and the like. Speaking generally, once again, it may be said to be unsuitable for the metropolitan system except after treatment to remove iron, turbidity, colour or H_2S, when occurring. Once it has been treated however, it is suitable for use. It is cool and palatable and does not need to be mixed with Hills water.

Trunk Mains and Service Reservoirs:

Water from the various hills sources is brought to Perth by a system of trunk mains. About half of the population is supplied more or less directly from branches from trunk mains, but for the remainder of the consumers, the water is brought first of all to a system of service reservoirs.

The major reservoirs in the north are Mt. Yokine, Bold Park, and Mt. Eliza, and those in the south, Thompson Lake, Hamilton Hill and Melville. There are also many smaller reservoirs to serve small localities. The present total capacity of these service reservoirs is 296,000,000 gallons.

The function of these reservoirs is to provide for daily and hourly variations in demand, to provide some reserve for excess heat wave demands and to tide over interruptions to the flow in trunk mains. They also serve to reduce fluctuations of pressure in the system. It is incidentally at these service reservoirs that the bore water is mixed with the Hills water.

The basis formerly used for the provision of service reservoirs was that the total capacity be twice the maximum daily demand. With increasing diversity of supply as new trunk mains have been provided, it has been possible to provide satisfactory service with proportionately less reservoir capacity than previously.

The system of hills reservoirs, bores, trunk mains, and service reservoirs, together with pumping stations and the network of distribution mains makes up the present metropolitan system.

Indicators of Growth:

Figure 1 shows three important indicators of recent growths in our water consumption. Plotted against the years from 1946/47 to 1969/70 are—

(i) The average daily consumption,

(ii) The average daily consumption of the peak week in each year,

(iii) The consumption on the maximum day of each year.

Average Daily Consumption:

The average daily consumption is of course a measure of the total water requirement. The prediction of the growth of this figure is used to determine the programming of the development of new sources. It is used to decide when new dams and when new bores are required.

You will notice that in 1946/47 the average daily consumption was 24.7 m.g. and in 1969/70 it was 87.2 m.g. In the years from 1946/47 to 1969/70 the average daily consumption has increased at the compound rate of 5.6%. In the last nine years the compound rate of increase has been 6.5%.

Later I shall use the statistics shown on this graph but for convenience in the form of annual consumption in connection with future demands.

The Average Daily Consumption of the Peak Week in each Year:

This graph is a more important one to us. The average daily consumption in a peak week is an indicator of our peaking problems and as such is an indicator of the need to provide trunk mains, pumping systems from the bores and service reservoirs.

During summer, efforts are made to see that as far as possible each morning, all our service reservoirs are full. When we have a heat wave the morning levels will fall day by day. Few heat waves last in their full force for more than a week, so over a week we expect some falling off in our storage. Except for this fall off, the trunk mains must meet the average daily consumption of the maximum week. The longer heat waves are extended, the more difficult it become to meet the demands but we have found that in this sort of emergency the public will generally respond readily enough to a request to conserve water. In the long run of course if the demands can not be met without imposing them, it is necessary to place restrictions on the use of water for sprinklers.

The Consumption for the Maximum Day in Each Year:

This figure is more a matter of interest than anything else because we can draw on reservoir storage to meet short term peaks. However, it is interesting to note that our record daily consumption has gone from 48,000,000 gallons in 1946/47 to 193,000,000 gallons on 2nd February, 1971. The rate of increase since 1946/47 has been 6%.

Annual Consumptions:

Figure 2 shows plotted against the passing years, the total annual consumption. Also plotted incidentally, is the annual consumption of artesian water. Here you will see that the total consumption in 1946/47 was 9,000,000,000 and in 1969/70 was 31,800,000,000 gallons. The problem now is to predict how this will grow in the future.

I do not propose to discuss refinements of such predictions but before turning to the possible growth of consumption and measures available to tackle it, I will refer to Figure 3 which indicates the growth in—

(i) The consumption per capita per day, and

(ii) The consumption per water service per day.

If we can predict the growth of these and the growth of population we can of course predict the consumption. You will notice that the consumption per service per day was remarkably consistent for many

years. The figure for 1947/48 was rarely passed until 1965/66. Since that date is has certainly climbed rapidly.

The consumption per capita per day has shown more regular increases, from 1946/47 to 1965/66 it rose from 89.7 gallons to 115.3 gallons, i.e. about 1.3 gallons per year. In the following four years however, it rose by 29.3 gallons and in 1969/70 the figure was 144.6. This is of course an extremely high figure for any Australian city.

Returning now to Figure 2, you will see plotted here up to the year 1990, is an indication of how consumption would increase should the rate of increase be 5% or 6%. In the years from 1950/51 to 1969/70, the annual consumption increased from 10,350,000,000 to 31,800,000,000 at a compound rate of increase of 6.1% per annum. In the years from 1960/61 to 1969/70 the annual consumption increased from 18,010,000,000 to 31,800,000,000 at a compound rate of increase of 6.5% (In the last six years the rate of increase has been 8.5% p.a.).

Factors which Affect Growth:

Increases in the volume of consumption result from the growth of population, of industry and of the area served. Recently in Perth the demands of industry become much more significant than formerly and some of the requirements of single industries are very high. Approaches have been made to the Board on behalf of industries requiring for one plant, up to as much as half of the total yield of the South Dandalup Reservoir.

Consumption is also affected by changes in the affluence and habits of the community. The recent tendency towards subdivision of land into smaller lots no doubt has some substantial effect on the volume of water needed for gardens.

Technical changes within the distribution system particularly those which result in pressure changes in the system, also affect the consumption. The pressure supplied to consumers by the Metropolitan Water Board is generally somewhat higher than it used to be formerly and in general also, the condition of pipes within private property is considerably better than it would be.

Steps Available to Reduce Consumption:

The methods of retarding consumption which are available to the Water Board include metering, restrictions on the sizes of service pipes, appeals to the public, water restrictions and water pricing policy. In the Perth region the extent of metering is as high as is practicable and as high as is required under the present rating system. Most of the services which lead to householders' meters are ¾" diameter. These two factors do help to limit consumption.

Here appeals to the public have generally been limited to short term appeals to reduce consumption during heat waves. In South Australia some time ago a sustained public campaign showed material benefit over a fairly lengthy time of water shortage.

I believe however, that in the long run, as it becomes more difficult to meet the growing demands, it will be necessary to introduce changes in water pricing policy directed towards the encouragement of economy in the use of water. As I propose to indicate, there is little doubt that demands will become much more difficult to meet in the future and the cost of meeting demands will be higher.

Water Restrictions:

The imposing of restrictions on the use of water remains one more method of limiting consumption and one which has been widely used both in Australia and overseas. Nevertheless it has always been a fairly unsatisfactory and unpopular means of achieving this purpose, particularly in Perth.

During the years 1953/54 to 1958/59, summer consumptions were increasing rapidly and the mains capacity did not allow unrestricted consumption during heatwaves. A number of schemes of varying severity for the restriction of the use of sprinklers were imposed. These were directed particularly at the morning and evening peaks.

During 1959/60 because of a shortage of water in storage, a complete ban on sprinklers was imposed from the 1st October and it continued for 120 days. The total ban and the publicity given to the reservoir position, had a considerable affect and reduced the consumption for the period by about 50%.

From the experience of this period it was estimated that a ban of 4 hours at peak periods reduced the summer daily consumption by 5%, a ban of 8 hours by 15%, a ban of 13 hours by 25% and a ban of 24 hours by 50%.

Future Demands:

In Perth we are certainly having growing difficulties in meeting the increasing demands for water. As these difficulties impress themselves upon the community it is likely to become more acceptable to institute measures to diminish the rate of growth of consumption. One would hope that by means of these measures it would be possible to keep the rate of growth substantially below the 6% rate, which has been averaged over the last 20 years. In order however to stress the importance of keeping this rate of growth within bounds, let us look at the position should this growth rate continue in the future. (See Figure 2). Taking the year 1969/70 as a base, a 6% rate of increase will give us consumptions as follows:

In 1974/75, 42,500,000,000 gallons per annum.
In 1979/80, 57,000,000,000 gallons per annum.
In 1984/85, 76,000,000,000 gallons per annum.
In 1989/90, 102,000,000,000 gallons per annum.

The corresponding figures if the rate of increase is limited to 5% p.a. will be:

In 1974/75, 41,000,000,000 gallons per annum.
In 1979/80, 52,000,000,000 gallons per annum.
In 1984/85, 63,000,000,000 gallons per annum.
In 1989/90, 85,000,000,000 gallons per annum.

Available Resources:

After the completion of the South Dandalup Dam about ten more dams may be built on the Board's catchments although on close investigation it may turn out that some of the smaller dams can not be justified. It is likely that the earliest will be South Canning, Wungong, North Dandalup and Gooralong. The total yield of these four would only be slightly greater than the Serpentine by itself. The yield of the remainder even if they are all built will be considerably less.

It is quite likely that before all these dams are completed, it will be necessary to build dams on the Murray or its tributaries. However, it has not yet been determined how the problems of the salinity of the Murray can best be overcome and it should be pointed out that the Murray River Catchment has not yet been assigned to the Board.

The total annual yield of the main catchments within the Board's area is about 45,000,000,000 gallons. Picking up all the smallest catchments would bring the yield to about 50,000,000,000 gallons.

These figures are the sum of the individual yields of the various streams. The use of computer techniques has proved that the total yields of a number of streams operating as a system is slightly greater than the sum of the individual yields and so we may take the absolute maximum yield that can be envisaged from the Board's present catchments as 53,000,000,000 gallons unless expensive catchment improvements are found to improve this yield.

Nevertheless, particularly in view of some doubts as to the likelihood of eventually damming every stream on my graph I have rounded this total yield to 50,000,000,000 gallons per annum, and indicated this an the right hand side of Figure 2.

Yield of Artesian Bores:

In. 1969/70 the total yield of the artesian bores was a little over 3,500,000,000 gallons, i.e. rather more than 10% of the amount supplied from the Hills.. No figure as to the probable ultimate output obtainable from artesian resources can be given with confidence. For purpose of estimation of the Board's resources it is necessary to make some assumption as to bore output and on the basis of existing experience, it has been assumed that the output from the deep aquifers equivalent to 10% of the total Hills yield will be possible. On this basis we can expect another 5,000,000,000 gallons per year of deep artesian water.

Thus taking an optimistic view of the total Hills and deep artesian resources, a total output of 55,000,000,000 gallons can be assumed. If these were our only resources and the rate of growth of our consumption continued to increase at a rate of 6% per annum, you would see that by the early 1980's our consumption would exceed our yields. (See Figure 2).

Augmentation of our Resources:

It is therefore clearly necessary to consider other means for increasing supply to the metropolitan area. Some of the means to be considered are:—

(i) Unconfined ground water.

(ii) Shallow artesian bores.

(iii) Reclamation of waste water.

(iv) Underground water recharge.

(i) The Murray River.

(vi) Desalination.

Unconfined Ground Water and Shallow Artesian Bores:

Large quantities of non-artesian ground water are available in the region and as I mentioned earlier this is used widely for parks, and public and private gardens. After treatment it may be suitable for use in the Metropolitan System and already a small treatment plant

is in operation, producing about 2 million gallons per day of good quality water. This plant is north of Mt. Yokine at Mirrabooka and it is supplying the suburbs in the Mirrabooka area.

It is well known that there are very substantial quantities of both unconfined ground water and good quality shallow artesian water over the length of the coastal plain. Treatment of this water in most cases, is not very difficult, but it is nevertheless not inexpensive. These sources will be of tremendous value in the coming years.. Many estimates have been made of the possible annual yield of the sources but the information available is too sketchy at present to be used with great confidence. However, it is necessary to make come assumptions if one is to establish the possible role of these supplies in meeting future demands.

In Figure 2 I have assumed that eventually 20,000,000,000 gallons per annum will be available. I believe that this is a conservative figure, but I am by no means sure. I have added it here firstly so that you may get some understanding of its great value and importance—there is no question about that.

My second purpose in showing this figure is to indicate to you roughly how much more time we may have before we are forced to use the more difficult resources.

Reclamation of Waste Water:

It is quite possible that within a few years it will be feasible to use suitably reclaimed waste water for industrial purposes. Already proposals have been considered quite seriously by companies investigating the feasibility of establishing plants in the Kwinana Area for the upgrading of the effluent from the Woodman Point Treatment Works for use in this way. Informal discussions have also been held with representatives of established industries in Kwinana with a view to making use of secondary effluent available from the new treatment works north of Medina. It appears that when the flow has reached 500,000 gallons per day further discussions may be fruitful. My next slide shows the distribution of sewage treatment works throughout the Metropolitan Area. The wastes from many of these have some potential for reclamation and re-use.

Helpful though such re-use may be it is likely to be limited and to have only a small effect in reducing the total water demands.

Underground Water Recharge:

I do not propose to spend much time on this subject for a number of reasons. Firstly it is likely to be of little benefit until our existing underground sources are more fully exploited. Secondly little work has been done on the problem in W.A. yet and thirdly, it is known that it is unlikely to be justified for many years. However, no doubt, in time both the effluents from sewage treatment works and those from the Metropolitan Main Drainage System will be used for this purpose.

Murray River:

The two main branches of this stream (the Hotham and the Williams) have average salinities in excess of those of the most saline of our artesian bores. An assessment was made of the average (weighted average) salinity for the period 1942 to 1962, of the Murray itself at a gauging station (G.S. 6) some 15 miles south east of Pinjarra. The average content of solium chloride was 1014 ppm corresponding to an average total salinity in excess of 1200 ppm. This is too saline to

be acceptable wthout either dilution with less saline water or some degree of desalination. Furthermore, the prospect is that in conventional use the salinity of the water in a major reservoir on this river would at times be substantially higher than this figure.

Some eight small tributaries of the Murray carry fresh water. Although damsites have not been selected, these could presumably be dammed and the streams used for water supply. The total yield from these 8 streams has been estimated at the low figure of approximately 9,500 million gallons per annum.

The total yield of the Murray itself has been estimated at about 45,000 million gallons per annum. It is thus a river of substantial importance. How it is to be used is yet to be decided and this may well depend upon the progress over the next two decades in the development of techniques for desalination of brackish water. There are nevertheless good prospects of making substantial use of the water without desalination.

There is little doubt that the river will be required for the Metropolitan System. A full study to integrate it with the other resources of the system will be required to arrive at the most economical pattern for its development. The yield of the Murray is indicated at the top of the column on the right hand side of Figure 2.

Desalination:

Significant advances have recently been made in the technology of desalination. Nevertheless, the cost of producing potable water from sea water on a scale likely to be considered seriously for Perth, remains high. Desalination of sea water may be a long term solution to the region's water needs, but it should be resorted to only when more economical resources have been exhausted.

A number of techniques for reducing the salinity of brackish waters are in the course of development. These aim to produce potable water from brackish water at costs far lower than the cost of desalinating sea water. In time it may become possible to use one or more of these techniques to reduce the salinity of the water of the Murray or of the water from our deep artesian bores.

Some idea of the present cost of desalination of brackish waters is available from the proceedings of the Water for Peace Conference held in the U.S.A. in 1967 and also from recent British reports.

If we had to face the problem of desalination of the Murray now, the method used would be likely to be electradialysis. We might plan for a plant of eventual capacity of 150 million gallons per day (imperial) in modules of say 25 million gallons per day—a module every 2 or 3 years.

Each module would be likely to cost about $6,000,000 with possibly some extra for pre-treatment of the water and for disposal of the saline wastes.

Desalination would take about 11 units of electricity per 1,000 gallons and would be likely to cost for a load factor of 90% about 15 cents per thousand gallons plus the cost of electricity, i.e. say 26 cents if electricity cost 1 cent per unit. (This is exclusive of pre-treatment). The completed plant taking 150 m.g.d. would consume 1.6 million units per day. (South Fremantle could run it comfortably).

Conclusion:

To conclude I should like to make the following predictions:—

(i) Our new main sources of water in this decade will be from new storages in the Hills. New dams will be built in fairly quick succession.

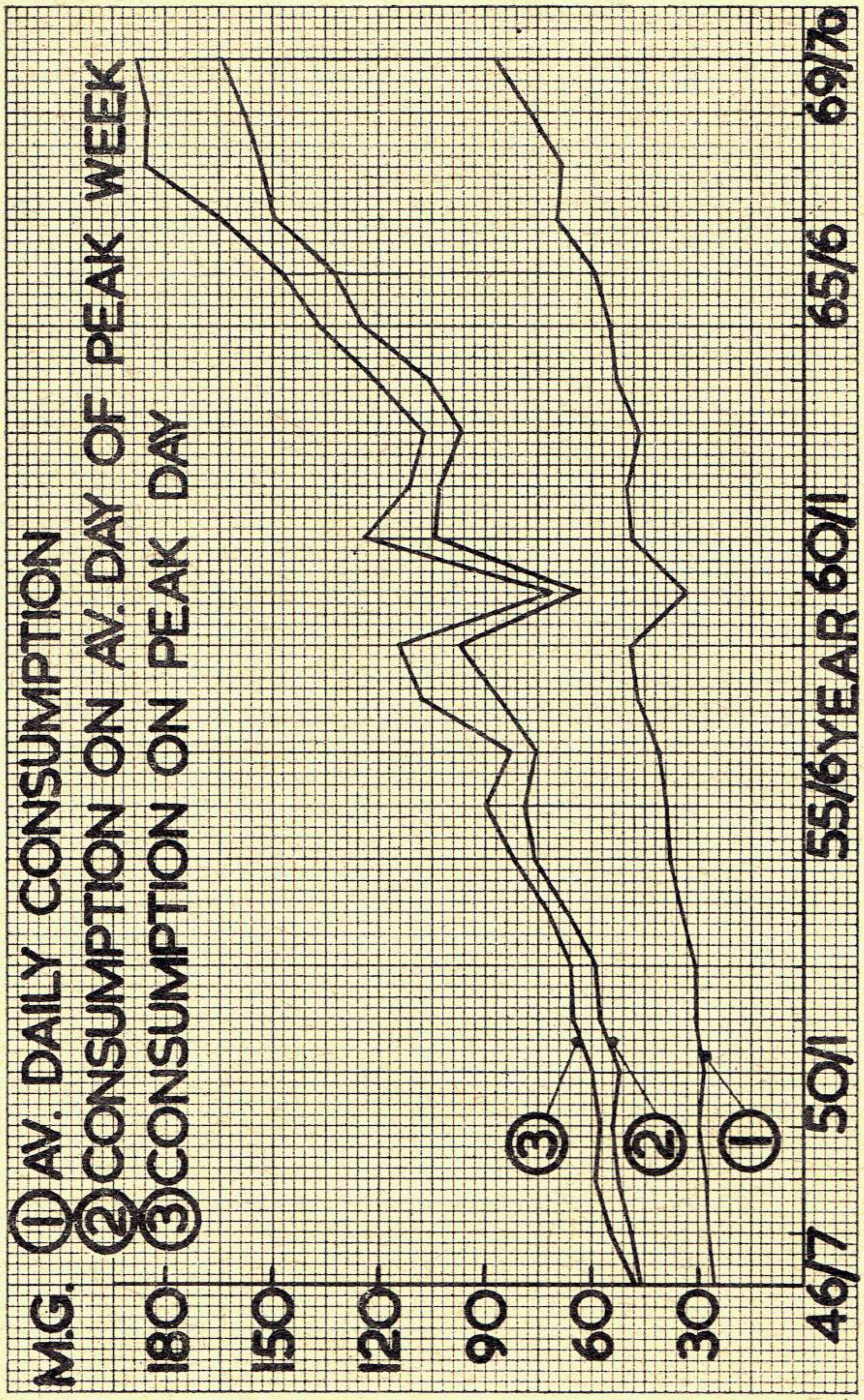
(ii) The sinking of deep artesian bores will continue at a steady rate.

(iii) The development of the shallow systems will be expanded at an increasing tempo.

(iv) Water will gradually become more expensive and in time quite heavy charges will be made for excess water.

(v) We will be re-using treated waste water for industry in the second half of the present decade.

(vi) We will be using water from the Murray in the second half of the 1980s and from the sea before the end of the century.


M.G.
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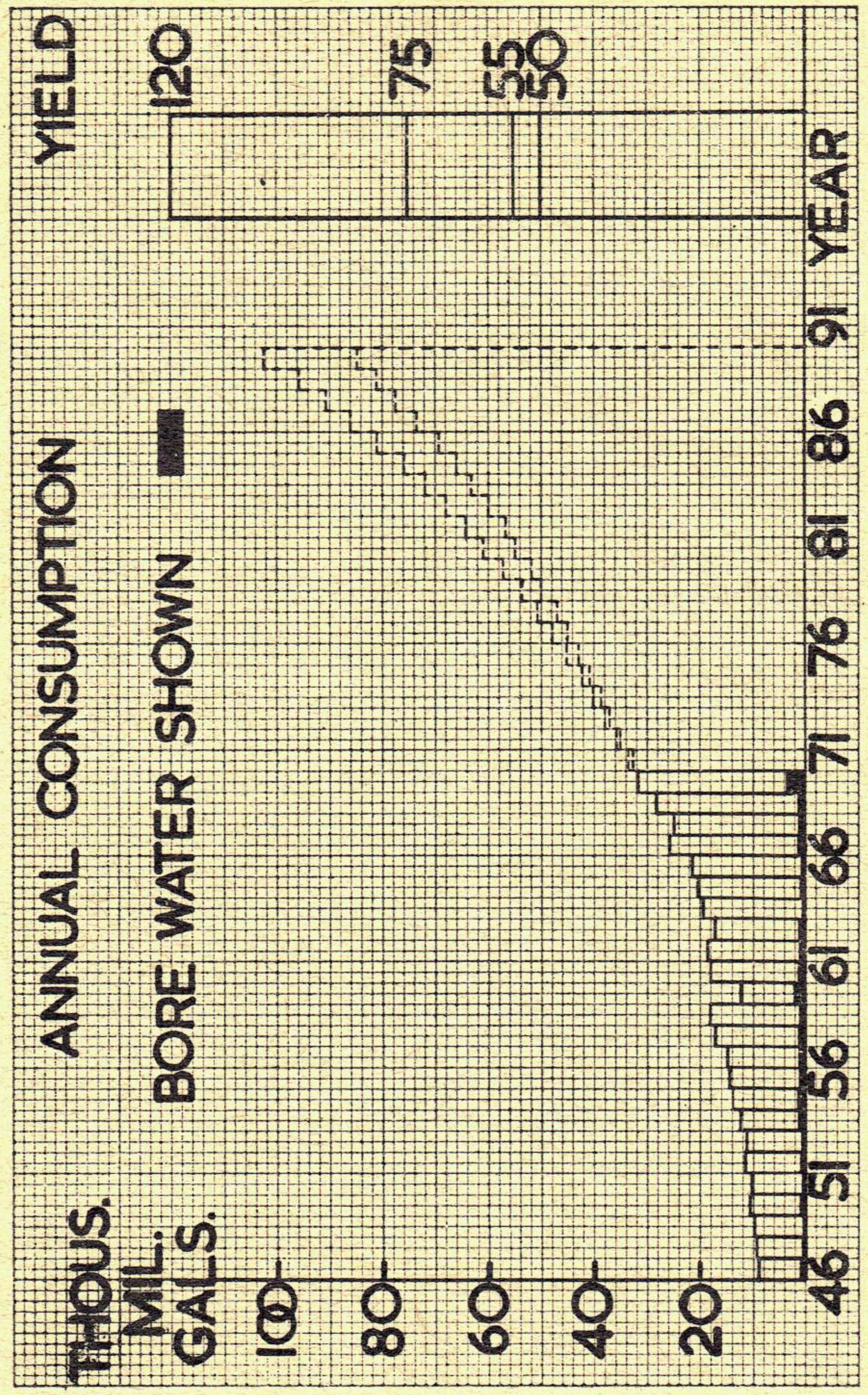
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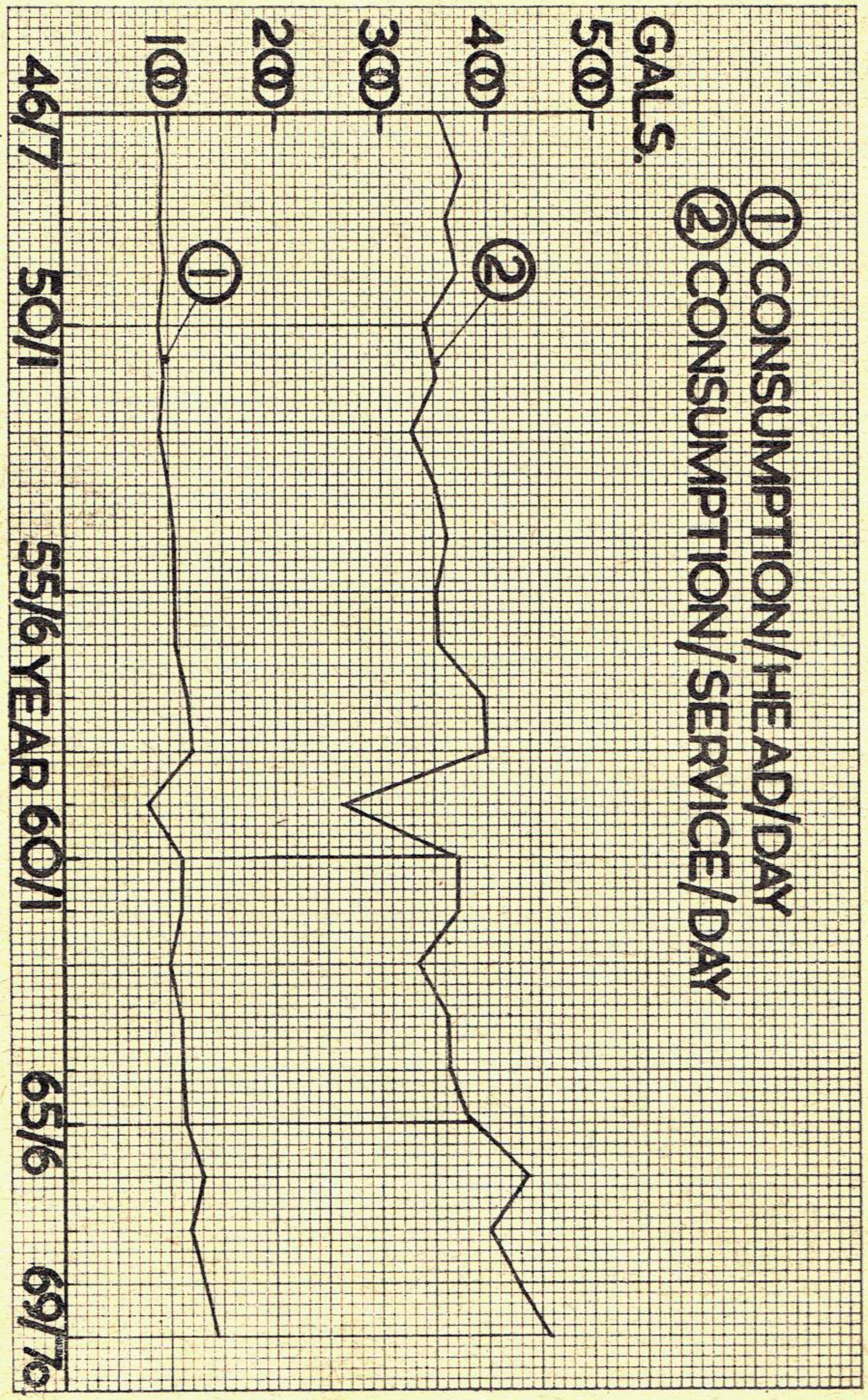
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